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THE MARINE AND ESTUARINE MOLLUSCS OF THE ALBANY AREA OF WESTERN AUSTRALIA

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INTRODUCTION

The State of Western Australia occupies the western third of the Australian continent and has a coastline of some 7 000 km. The marine and estuarine molluscs of the State are very poorly known. Only one attempt to summarize the entire molluscan fauna of the State has been made (Hedley 1916). References to the distribution in Western Australia of a number of species are recorded, where known, in most faunistic accounts of Australian molluscs (e.g. Cotton 1959, 1961, 1964; Allan 1950; MacPherson & Gabriel 1962; Wilson & Gillett 1971, 1979; Coleman 1975). Recently, molluscan faunas have been studied at points on the north coast (Wells in press) and the west coast (Chalmer, Hodgkin & Kendrick 1976; Wilson, Kendrick & Brearley 1978) but no similar studies have been made of the south coast of the state.

The marine fauna of Western Australia can be divided into two geographic zones (Wilson & Gillett 1971, 1979; Wells 1980). A tropical fauna on the north coast extends southward along the west coast and a warm temperate fauna extends northward. Thus the west coast fauna comprises an overlap mixture of southern temperate and northern tropical faunas. In addition, the overlap zone is characterized by species endemic to the area. The proportions of the three faunal components vary along the coast with tropical species predominant in the north and temperate species in the south. Of particular interest on the south coast, the Albany region may be regarded as the most important historical type locality for molluscs in the State. King George Sound was visited by the Astrolabe expedition in 1826. Quoy and Gaimard described a number of new species naming the Sound as the type locality (Quoy & Gaimard 1832-1835); Sir Joseph Verco visited the area early in this century and a number of species based on his collections were described by Cotton.

There is seldom an ideal time to publish a faunistic account for any region as new records are continually being documented. However, the importance of

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King George Sound as a type locality and the need for a contemporary account of the molluscs from the south coast of Western Australia prompted the authors to select the Albany region for this purpose. In addition, collections made by Western Australian Museum personnel from the south coast in recent years are predominantly from the Albany area, and provide a solid base for this preliminary faunistic account.

The Study Area

Albany is located on the south coast of Western Australia at 34°58′S and 117°57′E. The area has a mild climate with cool, wet winters and warm, dry summers. The mean maximum air temperature in July is 16.1°C and in February it is 23.4°C. Temperatures rarely exceed 35°C. The mean annual rainfall is 953.3 mm, 75% of which falls between May and October. The driest months are January and February (McKenzie 1962). Tidal range at Albany varies only 1.0 m during the year, from +0.2 m to +1.2 m (Anon 1978). The mean tidal range is 0.4 m. Tides are variable; most are semidiurnal, some are diurnal and occasionally the water remains static at the mid-tide level for several hours. Variations in barometric pressure may substantially alter predicted tidal levels (Hodgkin & DiLollo 1958).

Three marine embayments occur in the Albany area: Oyster Harbour, Princess Royal Harbour and King George Sound (**Fig. 1**).

Oyster Harbour is a shallow body of water, some 20 km^2 in area, which was formed by the drowning of the King and Kalgan Rivers systems during the Pleistocene. Both rivers still flow into the harbour with maximum flow during the winter and minimum flow in the summer. The only exchange with the sea is through a narrow channel at Emu Point which leads into King George Sound. In contrast to many other estuaries on the south coast the channel at the mouth of Oyster Harbour is kept constantly open by the scouring effect of water movement and the sand bar at the channel mouth never completely closes. McKenzie (1962) studied the geology of Oyster Harbour in detail. The lithotope of the harbour was found to be a composite of terrigenous and organogenic components. Most of the terrigenous sediment entering the harbour is brought in by the two rivers. The terrigenous fraction is well sorted medium-coarse to fine, silty sands. Organic carbonate is abundant throughout the harbour largely from the shells of molluscs which comprise over 90% of total animal biomass. Seagrass detritus is concentrated on the *Posidonia* slopes and in the deeper channels (McKenzie 1962).

Two zones were distinguished in Oyster Harbour by McKenzie (1962). He defined the upper harbour, which is most influenced by river flow and subject to large tidal effects, as brackish with salinities varying between 2.3‰ and 37.4‰. In contrast, the lower harbour has less tidal and salinity variation and was defined as marine. The annual range of water temperature at Emu Point in the marine zone is from 13-25°C. In addition to the brackish and

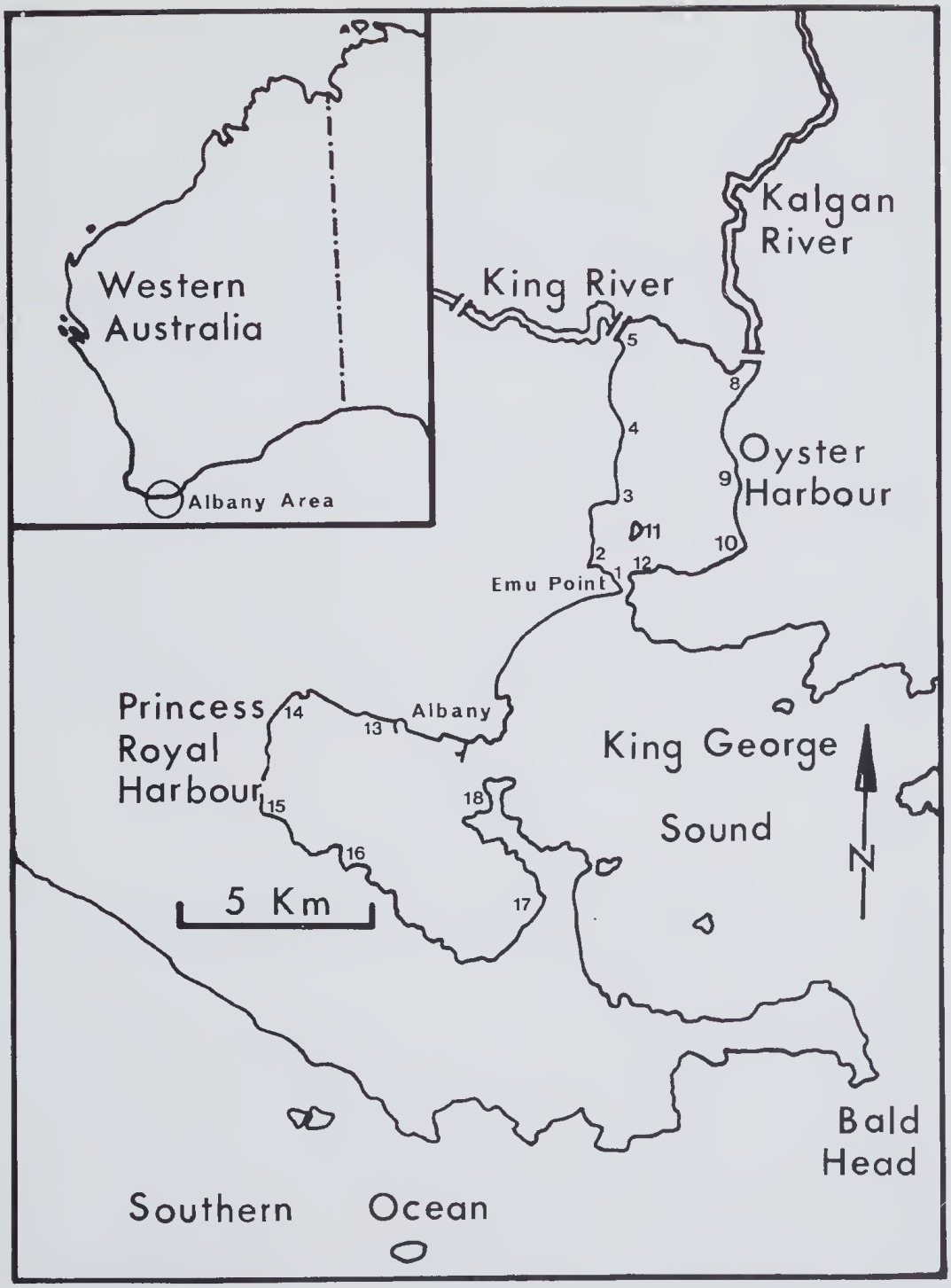

Figure 1. Map of the Albany area of Western Australia, showing the areas sampled in the surveys of Oyster Harbour and Princess Royal Harbour conducted in November and December, 1978.

marine zones McKenzie (1962) distinguished four habitats in Oyster Harbour: the littoral, which he considered to be from the high tide line to a depth of 0.5 m; sand banks, which occur down to 1.0 m; extensive *Posidonia* beds, on sublittoral slopes and deep channels which mark the former paths of the King and Kalgan rivers.

In contrast to Oyster Harbour, Princess Royal Harbour is poorly known. There are no rivers or streams leading into the harbour and fresh water input is from rainfall, runoff from adjacent land and groundwater seepage. Occupying an area of about 30 km^2 the harbour has a narrow channel at its eastern end which leads into the open ocean *via* King George Sound. The entrance channel and eastern end of the habour are subject to regular dredging to maintain a deep water channel to the port of Albany. Habitats within Princess Royal Harbour are more uniform than in Oyster Harbour. There are few areas of hard substrata apart from man-made structures such as piers and road bases. The harbour margins are gently sloping, sandy shores which give way subtidally to extensive *Posidonia* beds. The centre of the harbour has a mud bottom and seagrass is absent.

King George Sound lies between Oyster Harbour and Princess Royal Harbour and opens into the Southern Ocean. The Sound, which has an approximate area of 70 km^2, is protected from the full force of the open sea by Bald Head on its southern shore. The margins of King George Sound include granite rock and sandy shores. Subtidally, in areas where rock is absent, the bottom may be sand, mud or covered with seagrass.

METHODS

Two basic approaches were adopted to document the molluscan fauna of the Albany area: examination of existing museum collections, and additional collecting. The mollusc holdings of the Western Australian Museum were searched for material from the Albany region. In addition, the collections of the South Australian Museum were examined to confirm, where possible, records of species specifically mentioned by Cotton (1959, 1961, 1964) as occurring in the study area. Some of these records were confirmed but specimens could not be located for many species. However, since the records are in the published literature they are included in our list. McKenzie (1962) listed many mollusc species in Oyster Harbour but made no differentiation between living and fossil species. Since some of the species on McKenzie's (1962) list were based on fossil specimens (Hodgkin, pers. comm.) we have omitted these records. Additional collecting was carried out, primarily in littoral and shallow water areas, in the Albany region between September 1978 and June 1979. During November and December 1978, some dredging was carried out in the study area.

RESULTS AND DISCUSSION

Table 1 lists all species recorded to date specifically from the three study areas by previous workers and by ourselves; species recorded by previous workers, such as Cotton (1959, 1961, 1964), from south-western Australia but not specifically from Albany are not included. The heading 'Albany' includes species from adjacent areas such as the outer coast which have not been recorded in one of the three marine embayments and species recorded in the Museum collections from Albany without a specific area being indicated. Of the 318 species recorded to date there are 17 chitons, 189 gastropods, 107 bivalves, and 5 cephalopods. King George Sound is the type locality for 47 species: 9 chitons, 19 gastropods and 19 bivalves.

During November and December 1978, a detailed survey was made of the common molluscs at selected sites in Oyster Harbour and Princess Royal Harbour. Each site was visited and the intertidal and shallow subtidal molluscs were collected by hand. Species were assigned to semiquantitative cateogries of abundant, common and present. The localities of the sites are shown on **Fig. 1.**

The richest fauna in Oyster Harbour occurs at sites 1 and 2 which are just inside the harbour at Emu Point. This area was shown by McKenzie (1962) to be essentially marine in its faunal and water characteristics. Stations 1 and 2 are dominated by *Zeacumantus diemenensis, Batillariella estuarina, Salinator fragilis, Austrocochlea constricta, Hydrococcus graniformis, Katelysia scalarina,* and *Katelysia rhytiphora.* A detailed study of the molluscan community at site 2 has been made by Wells and Threlfall (in press). The fauna of stations 3 and 4 on the western side of Oyster Harbour is similar to that of stations 1 and 2, although densities appeared to be lower. *Posidonia* flats which characterise the subtidal areas of Oyster Harbour extend into the intertidal at stations 3 and 4. The eastern side of Oyster Harbour has the same mollusc species as the western side but the composition is somewhat different. *Salinator fragilis, Cominella tasmanica* and *Nassarius pauperatus* are all common on the western side of the harbour but are not as abundant on the eastern shore. The fauna at stations 5 and 8 at the mouths of the King and Kalgan Rivers respectively is impoverished. The dominant species in this area are *Bembicium melanostomum* and *Irus crenatus.* McKenzie (1962) reported that salinities at these two sites are essentially marine during most of the year. At the King River bridge the salinity varied from 31.7 to 37.3‰ during the entire year except for August when river flows were at their peak and the salinity declined to 2.3‰. A similar pattern occurred at the Kalgan River bridge. The minimum in August was 6.5‰. The only mollusc collected at both stations 6 and 7 in the rivers was *Xenostrobus pulex. Xenostrobus securis* and *Bembicium melanostomum* were collected at station 7 on the Kalgan River.

The bivalve *Pinna bicolor* was recorded in dense numbers in most areas of

Table 1. Mollusc species recorded from the Albany area. M=Marine, MA=Marine Affiinity; E=Estuarine.

SPECIES	OYSTER HARBOUR	PRINCESS ROYAL HARBOUR	KING GEORGE SOUND	ALBANY	DISTRIBUTION	AFFINITY	COMMENTS
CLASS POLYPLACOPHORA							
Family Lepidopleuridae							
Terenochiton erratus Hull, 1923			X		END	M	Type: KGS
Family Ischnochitonidae							
Ischnochiton cariosus (Dall, 1878)				X	TEMP	M	
Ischnochiton contractus (Reeve, 1847)			X		TEMP	M	
Ischnochiton lineolatus (Blainville, 1825)			X		TEMP	M	
Ischnochiton torri (Iredale and May, 1916)			X		TEMP	M	
Ischnochiton virgatus exaggeratus (Iredale & Hull, 1924)			X		TEMP	M	= *Stenochiton longicymba historia* Iredale & Hull, 1924 Type: KGS
Stenochiton cymodocealis Ashby, 1918			X		TEMP	M	
Family Callistochitonidae							
Callistelasma meridionalis (Ashby, 1919)				X	TEMP	M	
Family Cryptochitonidae							
Acanthochiton subviridis Torr. 1911			X		TEMP	M	Type: KGS
Acanthochiton sueurii (Blainville, 1825)			X		TEMP	M	Type: KGS
Glyptelasma matthewsi occidentalis Iredale & Hull, 1925			X		TEMP	M	Type: KGS
Notoplax speciosa H. Adams, 1861				X	TEMP	M	
Family Cryptoplacidae							
Cryptoplax striata occidentalis Iredale & Hull, 1925		X	X		TEMP	M	Type: KGS
Family Chitonidae							
Clavarizona hirtosa (Blainville, 1825)	X	X	X		END	M	= *Chiton georgianus* Quoy & Gaimard 1835 and *Plaxiphora pustulosa* Torr. 1911 both Type: KGS
Rhyssoplax geraldtonensis Ashby, 1911				X	TEMP	M	
Rhyssoplax torrianus Hedley & Hull, 1911				X	TEMP	M	
Family Aulochitonidae							
Loricella paucipustulosa Hull, 1923			X		END	M	Type: KGS

SPECIES	OYSTER HARBOUR	PRINCESS ROYAL HARBOUR	KING GEORGE SOUND	ALBANY	DISTRIBUTION	AFFINITY	COMMENTS
CLASS GASTROPODA							
SUBCLASS PROSOBRANCHIA							
ORDER ARCHEOGASTROPODA							
Family Haliotidae							
Haliotis conicopora Peron, 1816			X		TEMP	M	
Haliotis laevigata Donovan, 1806			X		TEMP	M	Type: KGS
Haliotis roei Gray, 1827			X		TEMP	M	
Haliotis scalaris (Leach, 1814)			X		TEMP	M	
Family Fissurellidae							
Ambylchilepas javanicensis (Lamarck, 1822)				X	TEMP	M	
Ambylchilepas nigrita (Sowerby, 1835)				X	TEMP	M	
Macroschisma producta Adams, 1850			X		TEMP	M	
Notomella candida (A. Adams, 1852)			X		TEMP	M	
Scutus antipodes Montsort, 1810		X	X	X	TEMP	M	
Tugali cicatricosa A. Adams, 1851			X		TEMP	M	
Family Acmaeidae							
Acmaea alticostata (Angas, 1865)	X		X		TEMP	M	
Acmaea onychitis (Menke, 1843)	X		X		END	M	
Patelloida nigrosulcata (Reeve, 1855)			X		TEMP	M	
Family Patellidae							
Patella chapmani Tenison-Woods, 1876				X	TEMP	M	
Patella peroni Blainville, 1825		X	X		TEMP	M	Type: KGS
Patellanax laticostata (Blainville, 1825)	X	X	X		END	M	Type: KGS
Family Trochidae							
Bankivia octona (Tate, 1891)				X	TEMP	M	
Calliostoma australe (Broderip, 1835)				X	TEMP	M	
Calliostoma ciliaris (Menke, 1843)				X	END	M	
Calliostoma interrupta (Wood, 1828)				X	TEMP	M	
Cantharidus apicinus (Menke, 1843)				X	TEMP	M	
Cantharidus bellulus (Dunker, 1845)	X				TEMP	M	
Cantharidus eximus (Perry, 1811)				X	TEMP	M	
Cantharidus irisodontes (Quoy & Gaimard, 1834)	X	X	X		TEMP	MA	
Cantharidus lehmanni (Menke, 1843)	X		X		TEMP	M	
Cantharidus pulcherrimus (Wood, 1828)			X		TEMP	M	
Chloridiloma concamerata (Wood, 1828)		X			TEMP	M	

SPECIES	OYSTER HARBOUR	PRINCESS ROYAL HARBOUR	KING GEORGE SOUND	ALBANY	DISTRIBUTION	AFFINITY	COMMENTS
Chloridiloma crinitus (Philippi, 1849)			X		END	M	
Clanculus consorbrinus (Tate, 1893)				X	TEMP	M	
Clanculus dunkeri (Koch, 1843)	X	X	X		TEMP	MA	
Clanculus maxillatus (Menke, 1843)				X	TEMP	M	Type: KGS
Clanculus personatus (Philippi, 1846)			X		TEMP	M	
Clanculus plebejus (Philippi, 1851)				X	TEMP	M	
Clanculus ringens (Menke, 1843)	X		X		TEMP	M	
Clanculus undatus (Lamarck, 1816)				X	TEMP	M	
Ethminolia vitiliginea (Menke, 1843)	X		X		TEMP	M	
Euchelus aspersa (Philippi, 1846)	X				TEMP	M	
Euchelus cf pumilio (Tate, 1893)				X	TEMP	M	
Gibbula lehmani (Menke, 1843)	X		X		TEMP	M	
Gibbula preissiana (Risso, 1826)				X	TEMP	M	
Monodonta constricta (Lamarck, 1822)	X	X			TEMP	MA	
Monodonta rudis (Gray, 1827)			X		TEMP	M	
Thalotia chlorostoma (Menke, 1843)			X		TEMP	M	
Thalotia conica (Gray, 1827)	X	X	X		TEMP	MA	
Family Stomatellidae							
Granata imbricata (Lamarck, 1822)	X	X	X		TEMP	M	
Stomatella auricula (Lamarck, 1816)	X	X	X		TEMP	M	Type: KGS
Family Turbinidae							
Astraea squamifera (Koch, 1844)	X	X	X		TEMP	M	
Elachorbis tatei (Angus, 1879)	X				TEMP	M	
Marmarostoma pulcher (Reeve, 1842)			X		END	M	
Ninella torquata (Gmelin, 1791)		X	X		TEMP	M	
Turbo jourdani (Kiener, 1839)			X		TEMP	M	
Family Phasianellidae							
Phasianella australis (Gmelin, 1791)		X	X		TEMP	M	
Phasianella ventricosa (Swainson, 1822)			X		TEMP	M	
Tricolia rosea (Angas, 1867)				X	TEMP	M	
Family Neritidae							
Nerita atramentosa (Reeve, 1855)	X	X	X		TEMP	M	
ORDER MESOGASTROPODA							
Family Littorinidae							
Bembicium auratum (Quoy & Gaimard, 1834)	X	X	X		TEMP	MA	
Bembicium melanostomum (Gmelin, 1791)	X	X	X		TEMP	MA	

SPECIES	OYSTER HARBOUR	PRINCESS ROYAL HARBOUR	KING GEORGE SOUND	ALBANY	DISTRIBUTION	AFFINITY	COMMENTS
Littorina unifasciata (Gray, 1826)	X	X	X		TEMP	M	Type: KGS
Family Hydrococcidae							
Hydrococcus graniformis (Thiele, 1928)	X	X			TEMP	E	
Family Rissoidae							
Merelina cyrta (Cotton, 1944)			X		TEMP	M	Type: KGS
Family Rissoinidae							
Schwartziella fiscina (Cotton, 1952)			X		TEMP	M	Type: KGS
Family Architectonidae							
Philippia lutea (Lamarck, 1822)				X	TEMP	M	
Family Vermetidae							
Serpulorbis sipho (Lamarck, 1818)	X	X	X		TROP	MA	
Family Potamididae							
Batillaria turritella (Quoy & Gaimard, 1834)				X	TEMP	M	
Batillariella estuarina (Tate, 1893)	X	X			TEMP	E	
Velacumantus australis (Quoy & Gaimard, 1834)				X	TEMP	MA	
Zeacumantus diemenensis (Quoy & Gaimard, 1834)	X	X	X		TEMP	MA	
Family Diastomatidae							
Diastoma melanoides (Reeve, 1849)				X	TEMP	M	
Finella pupoides	X				TEMP	M	
Family Cerithiidae							
Alaba fragilis	X				TEMP	M	
Ataxocerithium serotinum (A. Adams, 1855)	X		X		TEMP	M	
Bittium granarium (Kiener, 1842)	X	X	X		TEMP	E	
Eubittium lawleyanum (Crosse, 1863)	X				TEMP	E	
Campanile symbolicum (Iredale, 1917)		X	X		END	M	
Diala lauta (A. Adams, 1862)	X	X	X		TEMP	MA	
Diala monile (A. Adams, 1862)	X				TEMP	M	
Diala translucida (Hedley, 1905)	X				TEMP	M	
Family Cerithiopsidae							
Specula regina (Cotton, 1951)			X		TEMP	M	Type: KGS
Family Triphoridae							
Notosinister pfeifferi (Cross & Fischer, 1865)				X	TEMP	M	

SPECIES	OYSTER HARBOUR	PRINCESS ROYAL HARBOUR	KING GEORGE SOUND	ALBANY	DISTRIBUTION	AFFINITY	COMMENTS
Family Epitoniidae							
Epitonium australis (Lamarck, 1822)			X		TEMP	M	
Epitonium imperialis (Sowerby, 1844)				X	TROP	M	
Limascala rubrolineata (Sowerby, 1847)				X	TEMP	M	
Family Janthinidae							
Janthina exigua Lamarck, 1816			X		TROP	M	
Janthina janthina Linnaeus, 1758			X		TROP	M	
Janthina globosa Swainson, 1822			X		TROP	M	
Family Calyptraeidae							
Calyptraea calyptraeformis (Lamarck, 1822)	X				TEMP	M	
Crepidula immersa (Angas, 1865)	X		X		TEMP	M	
Family Hipponicidae							
Hipponix conicus (Schumacher, 1817)	X	X	X		TEMP	M	
Hipponix foliaceus (Quoy & Gaimard, 1834)				X	TROP	M	
Family Triviidae							
Ellatrivia merces (Iredale, 1924)		X	X		TEMP	M	
Family Cypraeidae							
Cypraea caputserpentis (Linnaeus, 1758)			X		TROP	M	
Cypraea comptoni (Gray, 1847)			X		TEMP	M	
Cypraea friendi (Gray, 1831)			X		TEMP	M	
Cypraea helvola (Linnaeus, 1758)			X		TROP	M	
Cypraea piperita (Gray, 1825)				X	TEMP	M	
Cypraea pulicaria (Reeve, 1846)				X	END	M	
Cypraea reevei (Sowerby, 1832)			X		TEMP	M	
Family Naticidae							
Eunaticina dingeldi (Iredale,)	X		X		TEMP	M	
Natica gualteriana (Recluz, 1844)			X		TROP	M	
Natica sagittata (Menke, 1843)	X				TEMP	M	
Polinices conicus (Lamarck, 1822)	X	X	X		TEMP	MA	
Sigaretotrema umbilicata (Quoy & Gaimard, 1833)	X				TEMP	M	
Sinum zonale (Quoy & Gaimard, 1832)	X	X	X		TEMP	MA	Type: KGS
Family Cassidae							
Cassis fimbriata (Quoy & Gaimard, 1833)		X	X		TEMP	M	
Phalium pauciruge (Menke, 1843)				X	TEMP	M	
Family Melanellidae							

SPECIES	OYSTER HARBOUR	PRINCESS ROYAL HARBOUR	KING GEORGE SOUND	ALBANY	DISTRIBUTION	AFFINITY	COMMENTS
Eulima bilineata (H. & A. Adams, 1853)				X	TEMP	M	
Family Styliferidae							
Hypermastus georgiiregis (Cotton & Godfrey, 1932)			X		TEMP	M	Type: KGS
Family Cymatiidae							
Septa tabulata (Menke, 1843)	X	X	X		TEMP	M	
Cabestana waterhousei (Adams & Angas, 1864)	X	X	X		TEMP	MA	
Ranella australasia (Perry, 1811)			X		TEMP	M	
Turritriton labiosa (Wood, 1828)	X		X		TROP	M	
ORDER NEOGASTROPODA							
Family Muricidae							
Bedeva paivae (Crosse, 1864)	X	X	X		TEMP	MA	
Muricopsis planilirata (Reeve, 1845)			X		TEMP	M	
Pterynotus triformis (Reeve, 1845)	X	X	X		TEMP	M	
Typhis yatesi (Crosse, 1865)			X		TEMP	M	
Family Thaididae							
Cronia avellana (Reeve, 1846)			X		TEMP	M	
Dicathais orbita (Gmelin, 1791)	X	X	X		TEMP	M	= *D. aegrota* Reeve, 1846 Type: KGS
Lepsiella flindersi (Adams & Angas, 1864)	X	X	X		TEMP	M	
Lepsiella vinosa (Lamarck, 1822)	X	X	X		TEMP	M	
Family Columbellidae							
Dentimitrella lincolnensis (Menke, 1843)	X				TEMP	M	
Pyrene scripta forma *bidentata* (Menke, 1843)		X			TROP	M	
Zafra cf. *atkinsoni* (Tenison-Woods, 1876)				X	TEMP	M	
Family Buccinidae							
Cominella eburnea (Reeve, 1846)	X	X	X		TEMP	MA	
Cominella tasmanica (Tenison-Woods, 1879)	X	X	X		TEMP	MA	
Family Nassariidae							
Nassarius burchardi (Philippi, 1851)	X	X			TEMP	M	
Nassarius nigellus (Reeve, 1854)	X		X		TEMP	M	
Nassarius particeps (Hedley, 1915)	X		X		TEMP	M	
Nassarius pauperatus (Lamarck, 1822)	X	X			TEMP	MA	

SPECIES	OYSTER HARBOUR	PRINCESS ROYAL HARBOUR	KING GEORGE SOUND	ALBANY	DISTRIBUTION	AFFINITY	COMMENTS
Nassarius pyrrhus (Menke, 1843)	X	X	X		TEMP	MA	
Nassarius rufulus (Kiener, 1834)				X	END	M	
Family Fasciolariidae							
Fusinus australis (Quoy & Gaimard, 1832)	X	X	X		TEMP	MA	
Fusinus tessellatus (Sowerby, 1830)				X	END	M	
Microcolus dunkeri (Jonas, 1846)	X				TEMP	M	
Family Olividae							
Amalda monilifera (Reeve, 1864)				X	TEMP	M	
Oliva australis (Duclos, 1835)			X		TEMP	M	
Family Marginellidae							
Marginella tridentata (Tate, 1878)				X	TEMP	M	
Family Mitridae							
Mitra australis (Swainson, 1820)			X		TEMP	M	
Mitra chalybeia (Reeve, 1844)				X	END	M	
Mitra glabra (Swainson, 1821)	X				TEMP	M	
Family Volutidae							
Amoria irvinae (Smith, 1909)				X	END	M	
Cottonia nodiplicata (Cox, 1910)				X	TEMP	M	
Ericusa fulgetrum (Sowerby, 1825)				X	TEMP	M	
Livonia roadnightae (McCoy, 1881)				X	TEMP	M	
Lyria mitraeformis (Lamarck, 1811)			X		TEMP	M	
Melo miltonis (Gray, 1834)			X	X	TEMP	M	
Family Cancellariidae							
Cancellaria spirata (Lamarck, 1822)			X		TEMP	M	
Sydaphera undulata (Sowerby, 1832)				X	TEMP	M	
Family Turridae							
Daphnella botanica (Hedley, 1918)			X		TEMP	M	
Guraleus vincentinus (Crosse & Fischer, 1865)			X		TEMP	M	
Kermia cf *periscelina* (Hedley, 1922)	X				TEMP	M	
Mitra guraleus australis (Adams & Angas, 1864)					TEMP	M	
Phenatoma harpularis (Desmoulins, 1842)					TEMP	M	Type: KGS
Splendrillia woodsi (Beddome, 1883)					TEMP	M	
Family Conidae							
Conus anenome (Lemarck, 1810)		X	X		TEMP	M	

SPECIES	OYSTER HARBOUR	PRINCESS ROYAL HARBOUR	KING GEORGE SOUND	ALBANY	DISTRIBUTION	AFFINITY	COMMENTS
Conus cocceus (Reeve, 1844)				X	END	M	
Conus dorreensis (Linnaeus, 1758)		X	X		END	M	
Conus klemae (Cotton, 1942)			X		TEMP	M	
Conus rutilis (Menke, 1843)				X	TEMP	M	
Conus segravei (Gatliff, 1890)			X		TEMP	M	
SUBCLASS OPISTHOBRANCHIA							
ORDER BULLOMORPHA							
Retusa apiculata (Tate, 1879)			X		TEMP	M	Type: KGS
Ringiculadda australis (Hinds, 1844)				X	TEMP	M	
Bulla quoyii (Gray in Dieffenbach, 1843)	X	X	X		TROP	MA	
Liloa brevis (Quoy & Gaimard, 1833)	X		X		TEMP	M	
Adamnestia arachis (Quoy & Gaimard, 1833)	X		X		TEMP	M	Type: KGS
Acteocina fusiformis (A. Adams, 1854)	X				TEMP	M	Type: KGS
Akera bicincta (Quoy & Gaimard, 1833)			X		TEMP	M	Type: KGS
Akera soluta (Gmelin, 1791)	X				TEMP	M	
Philine angasi (Crosse & Fischer, 1865)	X	X	X		TEMP	M	
ORDER PYRAMIDELLOMORPHA							
Syrnola elliottae (Cotton & Godfrey, 1932)			X		TEMP	M	Type: KGS
Turbonilla acicularis (A. Adams, 1853)	X				TEMP	M	
Pyrgiscus fusca (A. Adams, 1853)	X				TEMP	M	
ORDER PLEUROBRANCHIOMORPHA							
Berthella mediatas (Burn, 1962)				X	TEMP	M	
Berthellina citrina (Ruppell & Leuckart, 1828)				X	TEMP	M	
ORDER SACOGLOSSA							
Elysia australis (Quoy & Gaimard, 1833)		X			TEMP	M	
ORDER APLYSIOMORPHA							
Aplysia dactylomela (Rang, 1828)			X		TEMP	M	
Aplysia sp.			X		TEMP	M	
Stylocheilus longicauda (Quoy & Gaimard, 1833)			X		TEMP	M	
ORDER NUDIBRANCHIA							
Ceratosoma brevicaudatum (Abraham, 1876)			X		TEMP	M	

SPECIES	OYSTER HARBOUR	PRINCESS ROYAL HARBOUR	KING GEORGE SOUND	ALBANY	DISTRIBUTION	AFFINITY	COMMENTS
Chromodoris westraliensis (O'Donoghue, 1924)			X		TEMP	M	
Dendrodoris nigra (Stimpson, 1855)		X			TROP	M	
Doriopsilla carneola (Angas, 1864)				X	TEMP	M	
Doriopsilla miniata (Alder & Hancock, 1864)				X	TEMP	M	
Glaucus atlanticus (Forster, 1777)			X		TROP	M	
Madrella sanguinea (Angas, 1864)				X	TEMP	M	
Rostanga arbutus (Angas, 1864)				X	TEMP	M	
SUBCLASS PULMONATA							
Salinator fragilis (Lamarck, 1822)	X	X			TEMP	MA	
Siphonaria baconi (Reeve, 1856)	X		X		TEMP	M	
Siphonaria denticulata (Quoy & Gaimard, 1833)			X		TEMP	M	
CLASS CEPHALOPODA							
Hapalochlaena maculosa (Hoyle, 1883)			X		TEMP	M	
Octopus sp.			X		TEMP	M	
Sepia apama (Gray, 1849)			X		TEMP	M	
Sepia chirotrema (Berry, 1918)			X		TEMP	M	
Spirula spirula (Linnaeus, 1758)			X		TROP	M	
CLASS BIVALVIA							
ORDER NUCULOIDA							
Family Nuculidae							
Austronucula micans (Angas, 1878)			X		TEMP	M	
Family Nuculanidae							
Nuculana (Scaeoleda) verconis (Tate, 1891)			X		TEMP	M	
ORDER SOLEMYOIDA							
Family Solemyidae							
Solemya (Solemyarina) australis (Lamarck, 1818)	X		X		TEMP	M	Type: KGS
ORDER ARCOIDA							
Family Arcidae							
Barbatia pistachia (Lamarck, 1819)	X		X		TEMP	M	
Barbatia plicata (Dillwyn, 1817)				X	TEMP	M	

SPECIES	OYSTER HARBOUR	PRINCESS ROYAL HARBOUR	KING GEORGE SOUND	ALBANY	DISTRIBUTION	AFFINITY	COMMENTS
Anadara trapezia (Deshayes, 1840)	X	X			TEMP	M	
Family Limopsidae							
Limopsis tenuiradiata (Cotton, 1930)			X		TEMP	M	
Family Glycymeridae							
Glycymeris radians (Lamarck, 1819)		X	X	X	TEMP	MA	
Glycymeris striatularis (Lamarck, 1819)			X	X	TEMP	M	
ORDER MYTILOIDA							
Family Mytilidae							
Mytilus edulis planulatus (Lamarck, 1819)	X	X	X	X	TEMP	MA	
Xenostrobus pulex (Lamarck, 1819)	X	X	X		TEMP	MA	Type: KGS
Xenostrobus inconstans (Dunker, 1856)	X	X			TEMP	E	
Xenostrobus securis (Lamarck, 1819)	X				TEMP	E	
Modiolus areolatus (Gould, 1850)			X		TEMP	M	
Modiolus albicostatus (Lamarck, 1819)	X	X	X		TEMP	MA	
Modiolus penetectus (Verco, 1907)			X		TEMP	M	
Brachidontes ustulatus (Lamarck, 1819)			X		END	M	
Brachidontes erosus (Lamarck, 1819)	X	X	X		TEMP	MA	
Musculus cumingianus (Reeve, 1857)	X		X		TEMP	M	
Lithophaga teres (Philippi, 1846)				X	TROP	M	
Septifer biocularis (Linnaeus, 1758)				X	TROP	M	
Exosiperna scapha (Verco, 1908)			X		TEMP	M	
Exosiperna concava (Cotton, 1931)			X		TEMP	M	
Family Pinnidae							
Pinna bicolor (Gmelin, 1791)	X	X	X	X	TROP	MA	
Atrina (Servatrina) tasmanica (Tenison-Woods, 1876)			X		TEMP	M	
ORDER PTEROIDA							
Family Pteriidae							
Electroma georgiana (Quoy & Gaimard, 1835)	X		X		TEMP	M	Type: KGS
Pinctada fucata (Gould, 1850)		X			TROP	M	
Family Malleidae							
Malleus meridionalis (Cotton, 1930)		X	X		TEMP	M	
Vulsella spongarium (Lamarck, 1819)	X	X	X	X	ALL AUST	M	
Family Pectinidae							
Chlamys asperrimus (Lamarck, 1819)	X		X	X	TEMP	M	

SPECIES	OYSTER HARBOUR	PRINCESS ROYAL HARBOUR	KING GEORGE SOUND	ALBANY	DISTRIBUTION	AFFINITY	COMMENTS
Chlamys aktinos (Pettard, 1886)				X	TEMP	M	
Chlamys famigerator (Iredale, 1925)				X	TEMP	M	
Chlamys australis (Sowerby, 1847)			X	X	TEMP	M	
Semipallium (Mesopeplum) anguineus (Finlay, 1927)			X	X	TEMP	M	
Chlamydella favus (Hedley, 1902)			X		TEMP	M	
Pecten modestus (Reeve, 1852)			X		END	M	
Pecten (Notovolva) alba (Tate, 1887)				X	END	M	
Amusium balloti (Bernardi, 1861)			X		END	ZM	
Family Spondylidae							
Spondylus tenellus (Reeve, 1856)			X	X	TEMP	M	
Family Limidae							
Lima nimbifer (Iredale, 1924)			X	X	TEMP	M	
Limaria orientalis (Adams & Reeve, 1848)	X		X		TEMP	M	
Family Ostreidae							
Ostrea angasi (Sowerby, 1871)	X	X	X	X	TEMP	MA	
Ostrea folium (Linnaeus, 1758)	X	X			TEMP	M	
Crassostrea australis (Lamarck, 1819)			X	X	TEMP	M	Type: KGS
ORDER TRIGONIOIDA							
Family Trigoniidae							
Neotrigonia bednalli (Verco, 1907)			X		TEMP	M	
Neotrigonia horia (Cotton, 1961)			X		TEMP	M	
ORDER VENEROIDA							
Family Lucinidae							
Callucina (Pseudolucinisca) lacteola (Tate, 1897)	X				TEMP	M	
Notomyrtea mayi (Gatliff & Gabriel, 1911)			X		TEMP	M	
Notomyrtea bractea (Hedley, 1911)			X		TEMP	M	
Divalucina cumingi (Admas & Angas, 1863)			X		TEMP	M	
Divaricella occidua (Cotton & Godfrey, 1938)			X		TEMP	M	
Montilora adelaideana (Cotton & Godfrey, 1938)			X		TEMP	M	
Montilora paupera (Tate, 1892)			X		TEMP	M	
Family Ungulinidae							
Felaniella globularis (Lamarck, 1819)		X	X		TEMP	M	Type: KGS

SPECIES	OYSTER HARBOUR	PRINCESS ROYAL HARBOUR	KING GEORGE SOUND	ALBANY	DISTRIBUTION	AFFINITY	COMMENTS
Family Chamidae							
Chama ruderalis (Lamarck, 1819)	X			X	TEMP	M	
Family Leptonidae							
Myllita deshayesi (D'Orbigny & Recluz, 1850)				X	TEMP	M	
Myllita gemmata (Tate, 1879)			X		TEMP	M	
Family Lasaeidae					ALL		
Lasaea australis (Lamarck, 1818)		X	X		AUST	M	Type: KGS
Mysella donaciformis (Angas, 1878)			X		TEMP	M	
Arthritica helmsii (Hedley, 1915)	X				END	MA	
Family Carditidae							
Megacardita incrassata (Sowerby, 1875)			X		END	M	
Venericardia amabilis (Deshayes, 1852)				X	TEMP	M	
Family Crassatellidae							
Eucrassatella decipiens (Reeve, 1842)		X	X		END	M	
Salaputium probleemum (Verco, 1907)			X		TEMP	M	
Family Cardiidae							
Fulvia tenuicostata (Lamarck, 1819)	X	X	X	X	TEMP	MA	
Acrosterigma cygnorum (Deshayes, 1854)				X	TEMP	M	
Hemidonax chapmani (Gatliff & Gabriel, 1923)				X	TEMP	M	
Family Mactridae							
Mactra australis (Lamarck, 1818)	X		X	X	TEMP	M	Type: KGS
Mactra pura (Deshayes, 1854)		X	X	X	TEMP	M	Type: KGS
Mactra (Mactroma) ovalina (Lamarck, 1818)	X	X		X	TROP	MA	
Mactra abbreviata (Linnaeus, 1818)		X			TEMP	M	
Spisula (Notospisula) trigonella (Lamarck, 1818)			X	X	ALL AUST	M	Type: KGS
Lutraria rhynchaena (Jonas, 1844)		X	X	X	TEMP	M	
Family Mesodesmatidae							
Taria angusta (Reeve, 1854)		X	X		TEMP	M	
Taria cuneata (Lamarck, 1818)	X	X		X	TEMP	M	
Family Solenidae							
Solen vaginoides (Lamarck, 1818)	X		X		TEMP	M	

SPECIES	OYSTER HARBOUR	PRINCESS ROYAL HARBOUR	KING GEORGE SOUND	ALBANY	DISTRIBUTION	AFFINITY	COMMENTS
Family Tellinidae							
Tellina (Tellinota) albinella (Lamarck, 1818)		X		X	END	M	
Arcopagia (Pseudarcopagia) victoriae (Gatliff & Gabriel, 1914)			X	X	TEMP	M	Type: New Holland & KGS
Macomona mariae (Tenison-Woods, 1875)		X	X		TEMP	M	
Macomona deltoidalis (Lamarck, 1818)	X	X			TEMP	MA	
Family Donacidae							
Donax (Deltachion) electilis (Iredale, 1930)		X		X	TEMP	M	
Donax (Serrula) columbella (Lamarck, 1818)		X	X	X	END	M	Type: New Holland & KGS
Donacilla cuneata (Lamarck, 1818)		X			TEMP	M	
Family Psammobiidae							
Sanguinolaria (Psammotellina) biradiata (Wood, 1815)	X	X	X	X	TEMP	MA	
Gari alba (Lamarck, 1818)			X		TEMP	M	Type: KGS
Family Veneridae							
Circe scripta (Linnaeus, 1758)		X			TROP	M	
Circe sulcata (Gray, 1838)			X		TROP	M	
Callista (Costacallists) planatella (Lamarck 1818)			X	X	END	M	
Gomphina undulosa (Lamarck, 1818)			X	X	TEMP	M	Type: KGS
Paphia sulcosa (Philippi, 1844)		X			TROP	M	
Venerupis anomala (Lamarck, 1818)			X	X	TEMP	M	
Venerupis galactites (Lamarck, 1818)		X	X		TEMP	M	Type: KGS
Irus crenatus (Lamarck, 1818)	X	X		X	TEMP	MA	
Tawera lagopus (Lamarck, 1818)			X	X	TEMP	M	Type: KGS
Timoclea (Chioneryx) cardiodes (Lamarck, 1818)			X		TEMP	M	Type: KGS
Bassina disjecta (Perry, 1811)	X		X	X	TEMP	M	
Placamen placidum (Philippi, 1844)				X	TEMP	M	
Katelysia rhytiphora (Lamarck, 1818)	X	X	X	X	TEMP	MA	Type: KGS
Katelysia scalarina (Lamarck, 1818)	X	X	X	X	TEMP	MA	
Katelysia peroni (Lamarck, 1818)	X	X	X	X	TEMP	MA	Type: KGS
Family Petricolidae							
Petricola lucinalis (Lamarck, 1819)			X	X	TEMP	M	Type: KGS

SPECIES	OYSTER HARBOUR	PRINCESS ROYAL HARBOUR	KING GEORGE SOUND	ALBANY	DISTRIBUTION	AFFINITY	COMMENTS
ORDER MYOIDA							
Family Corbulidae							
Corbula iredalei (Cotton, 1930)	X				TEMP	M	
Family Gastrochaenidae							
Gastrochaena frondosa (Cotton, 1934)				X	TEMP	M	
Family Hiatellidae							
Hiatella australis (Lamarck, 1818)		X			TEMP	M	
Family Pholadidae					ALL		
Pholas australasiae (Sowerby, 1849)	X				AUST	M	
ORDER PHOLADOMYOIDA							
Family Laternulidae							
Laternula creccina (Reeve, 1860)	X				TEMP	M	
Family Myochamidae							
Myadora triggi (Cotton & Godfrey, 1938)			X		TEMP	M	

Oyster Harbour. However, every shell examined was dead. The species was recorded by McKenzie (1962) in Oyster Harbour but no mention was made of whether or not living specimens were collected. Living individuals are common in Princess Royal Harbour. It seems likely that *Pinna bicolor* establish dense populations in Oyster Harbour during favourable periods but these may be wiped out in unfavourable conditions, such as periods of reduced salinity.

Princess Royal Harbour is characterised by soft substrata. The associations found on these substrata include intertidal and shallow-water communities dominated by bivalves of the genus *Katelysia,* the gastropods *Zeacumantus diemenensis, Batillariella estuarina, Nassarius pauperatus,* and *Austrocochlea constricta.* The intertidal community at station 15 at the western end of Princess Royal Harbour is described elsewhere (Wells & Roberts in press). The intertidal communities of sandy shores in Princess Harbour are similar to those found in Oyster Harbour but there are several differences worth mentioning. The densities of the gastropods *Salinator fragilis, Hydrococcus graniformis* and *Batillariella estuarina* are higher in Oyster Harbour than in Princess Royal Harbour. *Katelysia rhytiphora* and *K. peroni* are more common in Oyster Harbour and *K. scalarina* is more numerous in Princess Royal Harbour. The typically estuarine bivalves *Xenostrobus securis* and *X. inconstans* are restricted to Oyster Harbour, and do not occur in Princess Royal Harbour. Live oysters *(Ostrea angasi)* although not as common as they once were, are found in Oyster Harbour but are absent from Princess Royal Harbour. These differences between the harbours are largely the result of the greater fresh water influence in Oyster Harbour.

In both harbours the intertidal sandflats give way subtidally to beds of the seagrass *Posidonia.* The molluscan communities of the *Posidonia* flats have not been studied by us, but information on this in Oyster Harbour is contained in McKenzie (1962). The few hard substrata in Princess Royal Harbour have zoned communities characterised by a chiton *(Clavarizona hirtosa)* zone in the upper intertidal which grades into a zone dominated by the mussel *Mytilus edulis planulatus.* Associated with the chiton and mussel zones are the bivalves *Lasaea australis* and *Irus crenatus.* The major predatory gastropods in Princess Royal Harbour are *Dicathais orbita* in the intertidal and *Fusinus australis* subtidally.

King George Sound has the greatest habitat diversity in the study area. Habitats range from sheltered beaches to the more exposed shores of Frenchman's Bay. Substrata range from sand beaches to rock outcrops and boulders. The sheltered sandy areas of Middleton Beach support the seagrass *Posidonia* with large numbers of live *Pinna bicolor. Katelysia* is not present in number anywhere in King George Sound, but bivalves of the genera *Mactra* and *Glycymeris* are frequently washed up on the beach and are probably abundant subtidally. The more exposed sand beaches of Frenchman's Bay are characterised by the surf clams *Donax columbella* and *Taria angusta.* Rocks in the Sound are

classically zoned with the littorinid *Littorina unifasciata* in the upper intertidal giving way to *Nerita atramentosa* in the lower intertidal. Limpets such as *Patella peroni* also occur in the lower intertidal. The intertidal of more exposed localities is covered by mats of *Xenostrobus pulex*. Haliotids, turbinids and trochids are common in the shallow subtidal area.

The molluscan fauna of the Albany area clearly belongs to the warm temperate category, with 88.5% of the species belonging to this grouping. Nineteen species were classified as tropical. While the classification of species as either warm temperate or tropical is useful in discussing distributions it is not an all or none phenomenon. This is particularly true for the neustonic species of *Janthina* and *Glaucus atlanticus*. Wells (1980) has shown that there is a gradual decline in the number of tropical species at points progressively farther south on the west coast. Some species which occur in tropical areas over most of their ranges are able to survive the colder water temperatures of the more southerly localities. While the fauna of southern Australia is largely distinct from that of the tropical north a number of tropical species have been recorded on the south coast. Cotton (1959) for example reported 10 species of euthecosomatous pteropods and six of *Janthina* from the waters of the southern shores of the continent; all of these are generally regarded as being tropical and are easily dispersed by currents. Burn (1966) discussed the zoogeography of 39 species with tropical or tropical/warm temperate distributions.

The west coast of Western Australia is an area of overlap between the tropical fauna of the north coast and the warm temperate fauna of the south coast (Wilson & Gillett 1971, 1979; Wells 1980). Most of the species endemic to the state occur in the overlap zone. Wells (1980) found that 8.6% of the prosobranch gastropods examined are endemic, and 29 of the 38 endemic species he studied have at least part of their distributions on the west coast. Wilson, Kendrick and Brearley (1978) studied the prosobranch gastropod and bivalve molluscs of Cockburn Sound on the west coast in detail. Of the 255 species examined, 14% are endemic to Western Australia. In contrast to these figures for the west coast, the south coast of Albany has a lower rate of endemicity, 8.0%.

Chalmer, Hodgkin & Kendrick (1976) examined the molluscs of the Swan River estuary, dividing them into four groupings based on a subjective assessment of their salinity tolerances. Marine species were defined as those with a marine distribution and only a temporary or sporadic estuarine representation. Species of marine affinity are those marine species which also have a more or less continuous estuarine representation. Estuarine species have no marine freshwater representation. Freshwater species are not found in the marine environment and have only limited estuarine distributions. Application of these subjective categories to the data for the Albany area resulted in **Table 2,** which also includes the comparable information for the Swan River estuary. The comparison illustrates a similarity in the faunal components of

Table 2. Environmental affinities of molluscs from the Albany area compared with those from the Swan River Estuary.

Affinity	* Swan River Estuary	Oyster Harbour		Princess Royal Harbour		King George Sound		Albany	
	%	No. Species	%	No. Species	%	No. Species	%	No. Species	%
Marine	66	70	64.2	54	60.0	169	86.2	277	87.0
Marine Affinity	26	33	30.3	32	35.5	26	13.3	35	11.3
Estuarine	7	6	5.5	4	4.5	1	0.5	6	1.7
Freshwater	1	0	0	0	0	0	0	0	0
Total	100.0	109	100.0	90	100.0	196	100.0	318	100.0

* After Chalmer, Hodgkin & Kendrick (1976)

the Swan estuary and Oyster Harbour, both of which have major fresh water inputs. It also illustrates the predominantly marine components of the King George Sound malacofauna. Interesting features to emerge from the comparison are the relative proportions of the different faunal components of Princess Royal Harbour. Although having a similar proportion of estuarine forms as Oyster Harbour, Princess Royal Harbour has a higher proportion of species falling into the marine affinity category and a lower proportion of marine forms than Oyster Harbour (**Table 2**). This is despite the fact that Princess Royal Harbour receives no large rivers as does Oyster Harbour and suggests a greater fresh water input than is apparent. In addition, an intertidal sandflat on the Oyster Harbour side of Emu Point (the boundary between King George Sound and Oyster Harbour) has many predominantly marine species which have not been reported at other points in the harbour; the water in this area is essentially marine throughout the year (McKenzie 1962). By contrast, the entrance to Princess Royal Harbour, where one would expect greatest marine influences, is subject to human disturbance in the form of dredging which might result in an impoverishment of the marine faunal component in this area. The analysis for 'Albany' is included in **Table 2** for completeness, but cannot be considered comparatively as it includes species from unspecified localities within the study area.

The molluscan fauna of the three embayments in the Albany area is largely marine. Of the 318 species recorded in this study, 312 (98%) are either marine or marine affinity. King George Sound is the most diverse with 196 species recorded. Of these, 195 are marine or marine affinity and only a single species is classified as estuarine. The molluscan faunas of both Oyster Harbour and Princess Royal Harbour are not as rich as that of King George Sound and many marine species occurring in the Sound are absent from the harbours. While there are a few estuarine species which live in the harbours and not in the Sound, these are not enough to offset the absence of marine species.

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